Mass Spectrometric Forensics of Explosives Using A Remotely Piloted Small Helicopter

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Introduction
Mass spectrometry is often used to investigate explosives, both in unexploded and post - exploded forms. This paper investigates the application of a small, remotely piloted helicopter to collect explosive gas for mass spectral (MS) analysis. The unmanned air vehicle (UAV) system was used to safely sample and detect leaks of propane gas, but the method might be applied to other hazardous gases.

Objective
The specific objective of this study was to determine if a small helicopter could be used to sample an explosive concentration of gas for analysis by mass spectrometry. We further wished to determine if the explosive hazard was caused by either an accidental release of gaseous hydrocarbons or by intentional use of high explosives such as TXT, RDX, PENT etc..

Background
One recent case investigated by the federal government was the Herrig Brothers Poultry Farm propane explosion that occurred in Albert City, Iowa, on the morning of April 8, 1998. In the investigation report (1), the explosion was determined to be the result of a propane leak. The normal method of monitoring of propane leaks after explosion poses a safety risk when done by hand. Using this case as the working model, we set forth to determine if the RC helicopter system will allow safe, remote monitoring of propane leaks, and use mass spectrometry to confirm the results.

Methods and Equipment

Propane Detection
Detecta-Gas
A Detecta-Gas Portable gas detector DB2000G (2) was attached to the RC helicopter to detect propane leaks. The detector was operated according to the instructions shipped with the unit. The Detecta-Gas Portable gas detector is simple to use. Remove the protective sensor cap, turn the unit on with the power switch, the buzzer will sound and the red LED will illuminate. Once this has stopped and the green LED lights, the unit is ready to detect gas. Move the sensor to the area to be tested for gas; an alarm will sound when the unit detects gas. The sensor was mounted to the RC helicopter.

Draeger Tube
Air was drawn through the Draeger tube (3) by modifying the air intake of the helicopter engine to verify the presence of propane gas after the test run. The amount of air drawn through the tube could be varied. The propane concentration was determined by comparing the color change with chart included with the Draeger tubes.

Helicopter Used in Experiments
A specially modified Bergen Observer RC helicopter was chosen as the aerial video platform (4).

Procedure

1) Propane detector mounted to the RC helicopter and turned on
2) Fresh Dreager propane detection tube attached to air intake on helicopter.
3) Wireless camera and digital camera attached to the helicopter

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4) Slow leak (1 lb/hr) from a 20-pound tank of propane started by turning valve.
5) Helicopter hovered near fuel tank, up wind and down wind
6) Red LED on Detecta-Gas could be seen in wireless video image
7) Mass spectrometry and Dreager tubes confirm propane present

Results

E.I. MASS SPECTRUM OF PROPANE GAS

m/Z	26	27	28	29	39	41	42	43	44
R.I.	15	45	60	100	20	18	8	20	21

Detecta-Gas Portable gas detector DB2000G

1) No signals from propane detector **up wind** from propane tank
2) Signals were observed **down wind** from propane tank
3) Weaker signals down wind up to 20-30 feet from propane tank
4) Strongest vapor detection was recorded from the on-board detector when the engine on RC helicopter was off (after landing), rotor stopped and wind was light 0-5 MPH.

Conclusions

The initial results indicate the method used for sampling hazardous gases using a remotely piloted vehicle is reasonable. The best results for the on-board detector were achieved when the helicopter was landed downwind and turned off. The best results for confirmation from MS analysis of the sampling tubes was when the helicopter was hovered just above the ground, downwind of the source. This indicates that the air disturbance caused by the rotor affected the quantitative results, but provided adequate qualitative results to provide a basis for further action.

Findings:

1) The combination of RC helicopter/propane detector/wireless video gave clear indications of the point source of propane **DOWNWIND** without igniting the propane
2) The combination of helicopter/propane detector/wireless video did not give any indication of the point source of propane **UPWIND** from the source.
3) Mass spectrometry and Dreager tubes confirmed presence of propane
4) Strongest signals from the detector were obtained when a.) helicopter on ground b.) engine shut down c.) rotor not spinning d.) calm winds (0-5 MPH) e) helicopter downwind from gas release point

References

1). Buena Vista County Sheriff's Department, Sheriff Chuck Eddy. http://www.chemsafety.gov/1 Permission Obtained on 26 Mar 03, from U.S. CHEMICAL SAFETY AND HAZARD INVESTIGATION BOARD Phone (202) 261-7600 Fax (202) 261-7650 Email info@csb.gov Herrig Bros. Farm "Poultry Farm Propane Explosion" Albert City, Iowa - April 8, 1998 Board Reference No. 98-007-IA

2.) Detector : Detecta-Gas Portable gas detector DB2000G, Source: Camping Survival, parent company is JHL Supply P.O. Box 720 • Fulton, NY 13069, Toll Free: (800) 537-1339, Local: (315) 592-4794, Fax: 315-592-4796

3.) Draeger Tubes: Source: AFC International, Inc., PO Box 894, DeMotte, IN 46310, 715 SW Almond St, Ste C, DeMotte, IN 46310,800-952-3293 219-987-6825 Fax 219-987-6826 E-mail sales@afcintl.com , home: http://www.afcintl.com/index.html

4.) Helicopter: Source: Bergen RC Helicopters, 1101 FOLLETT DR., CASSOPOLIS. MI 49031 PH: 616-445-2060 FAX: 616-445-2250 Email cbergen@bellsouth.net or http://www.bergenrc.com/Contact.asp

The modified RC helicopter used to perform the remote sampling. Note the gimbal mounted video system.